Climate Change in the Northeast US: Past, Present, Future

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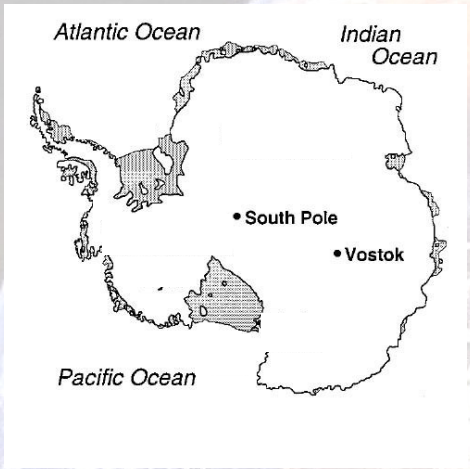
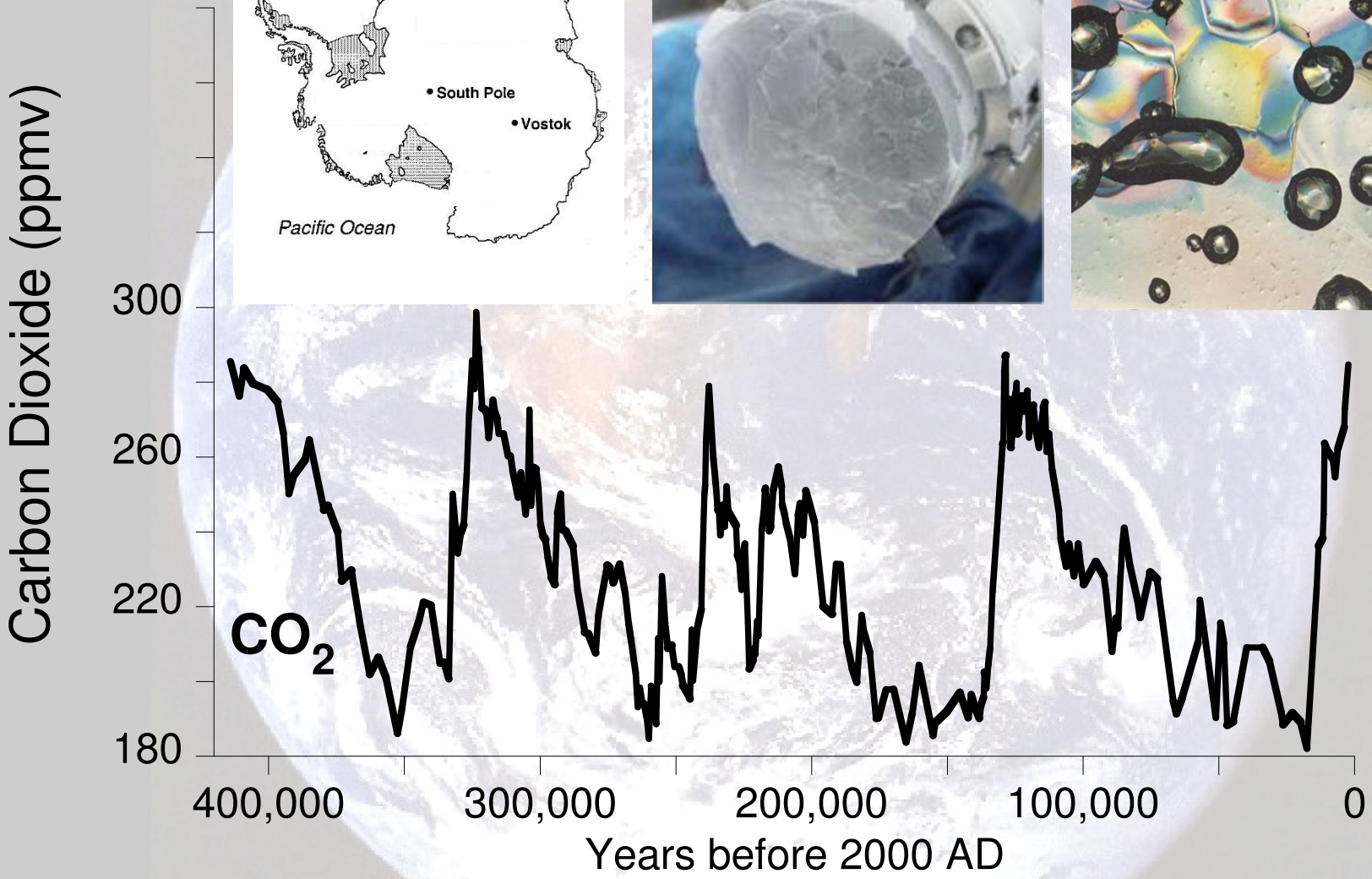
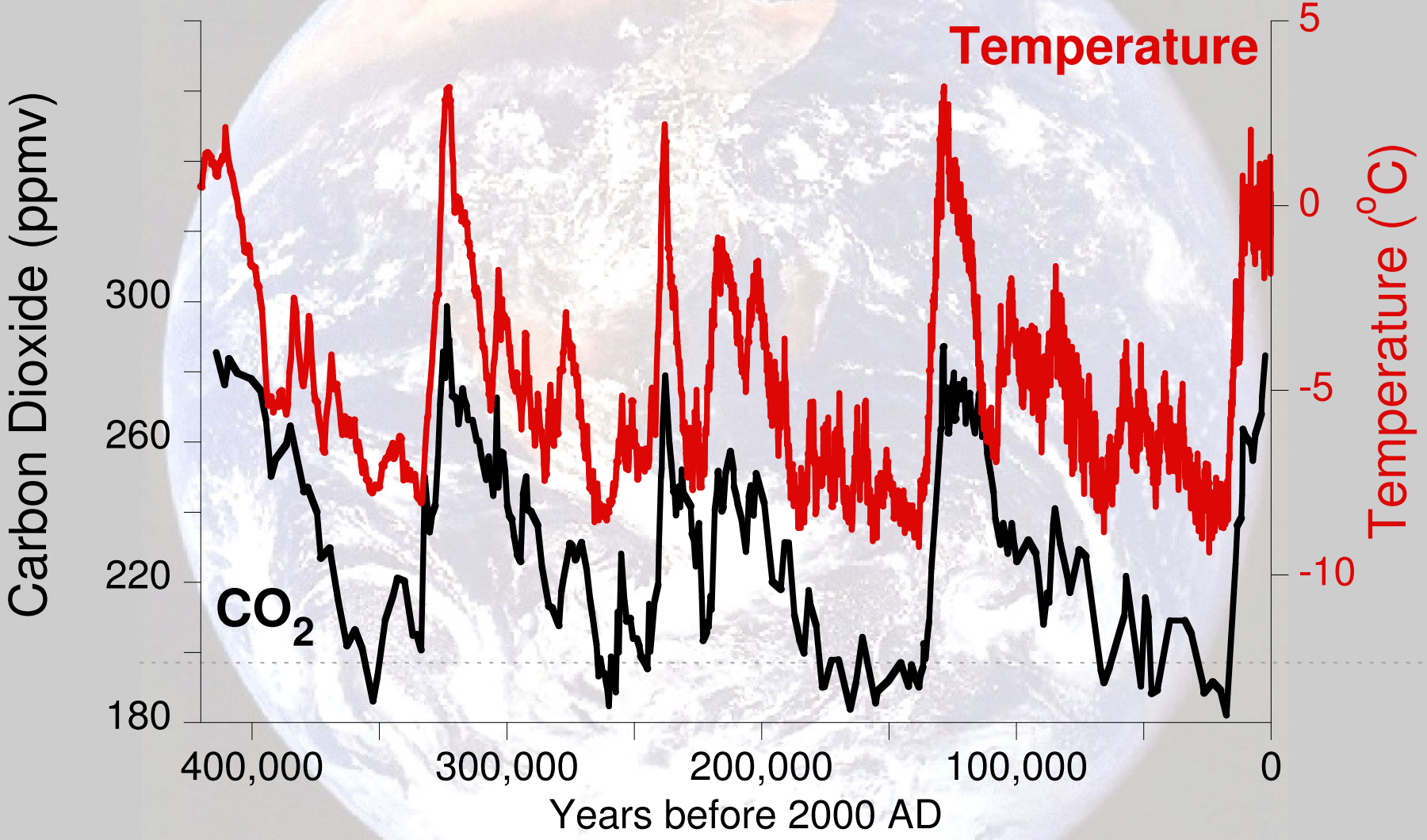
Vostok Ice Core - Atmospheric Carbon Dioxide





Petit et al., 1999

Vostok Ice Core - Carbon Dioxide & Temperature



Petit et al., 1999

Vostok Ice Core - Atmospheric Carbon Dioxide

Business as Usual

Clean Energy & Efficiency

Current

Carbon Dioxide (ppmv)

1000
800
600
400
200

400,000
300,000
200,000
100,000
0

Years Before 2100 AD

IPCC 2001

Global Temperature 1880-2005
(meteorological stations)

Temperature Anomaly (°F)

1
0
-1

1880 1900 1920 1940 1960 1980 2000

Year

Annual Mean
5-year Mean

http://www.giss.nasa.gov

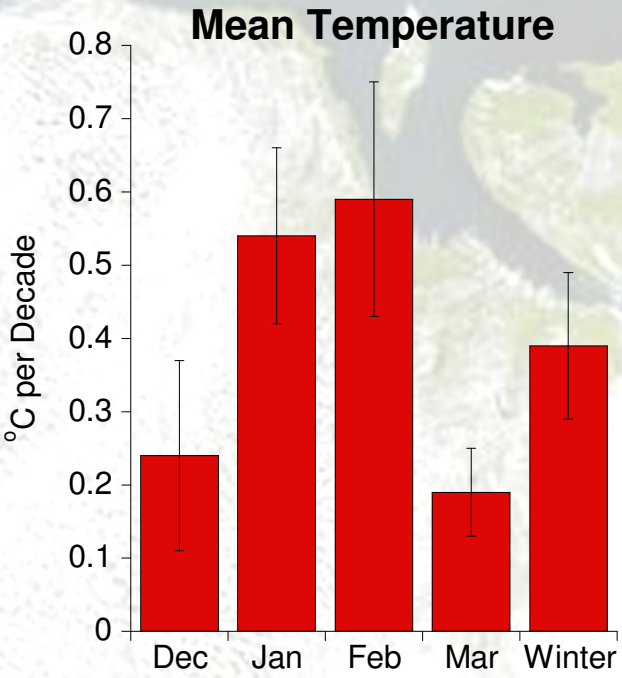
Indicators of Climate Change in the Northeast US over the last 30-40 yrs

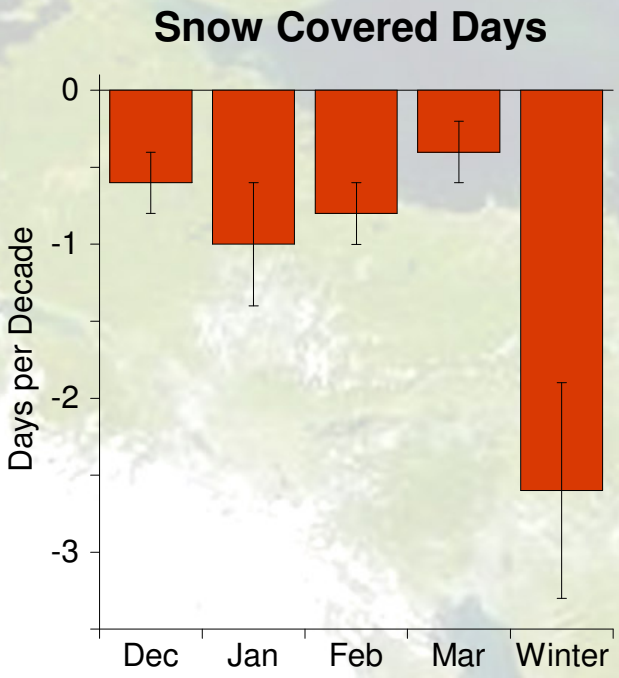
- **Winter warming**
- **Decreased snowfall**
- **Fewer days with snow on ground**
- **Lake ice out dates earlier**
- **Lilac bloom dates earlier**
- **More frequent extreme precipitation**
- **Earlier spring runoff**
- **Sea levels continuing to rise**

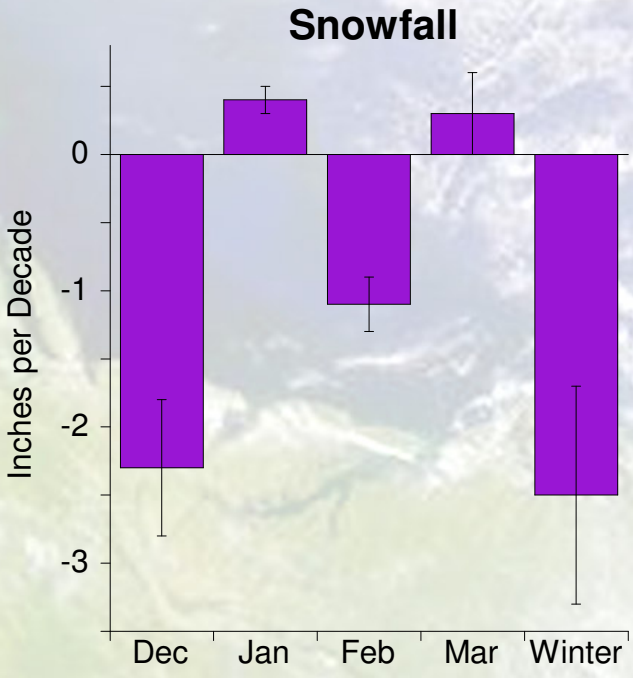
Hodgkins et al., 2002; 2003; Wolfe et al., 2005;
Wake and Markham, 2005; Wake et al., 2006

Trends in Northeast US Winter Climate

(1965-1975) - 2005

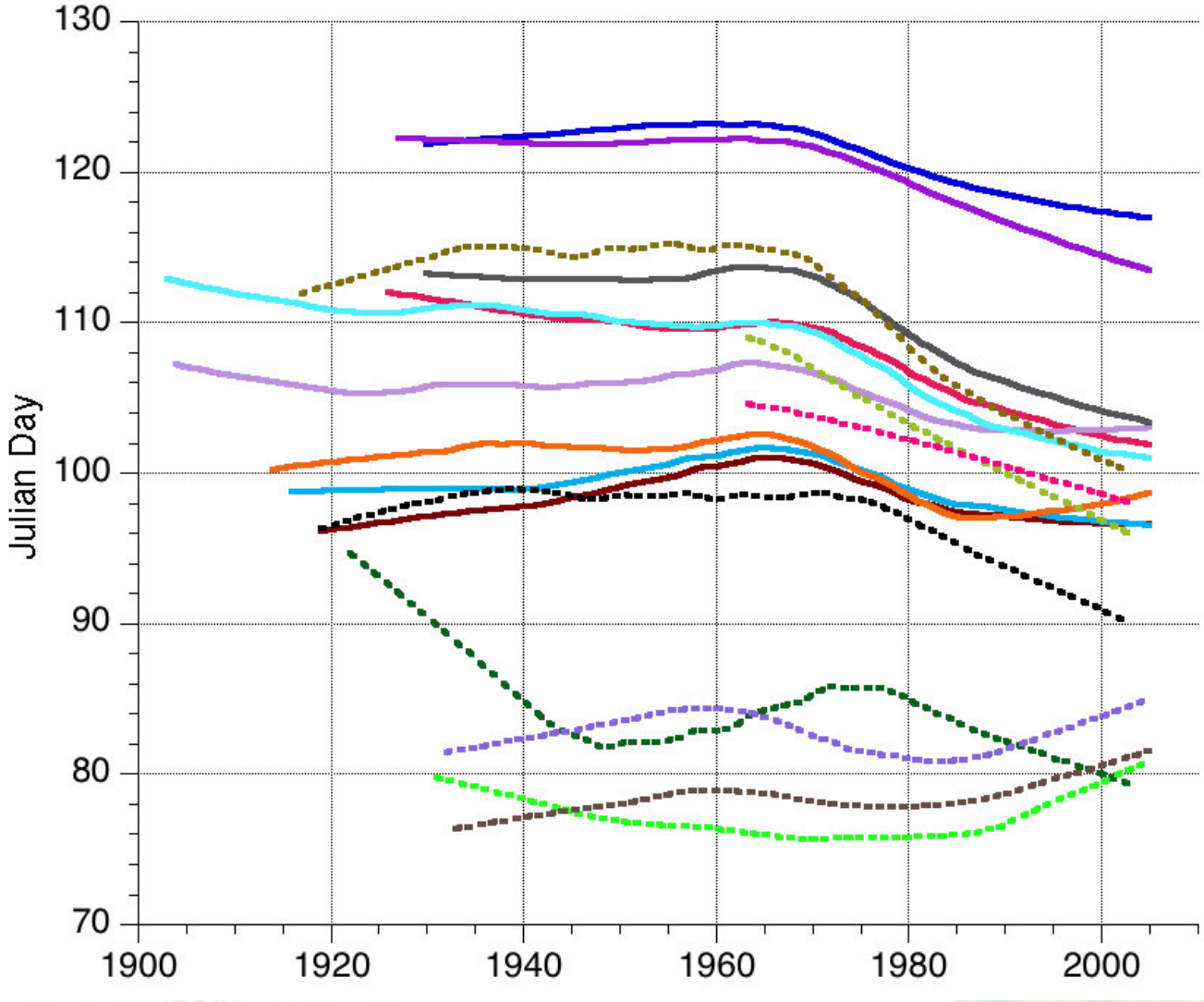


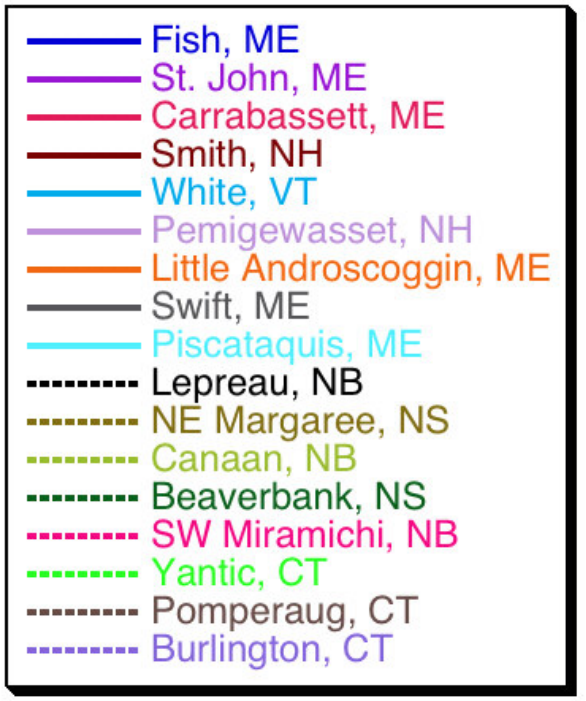




Burakowski et al., 2008

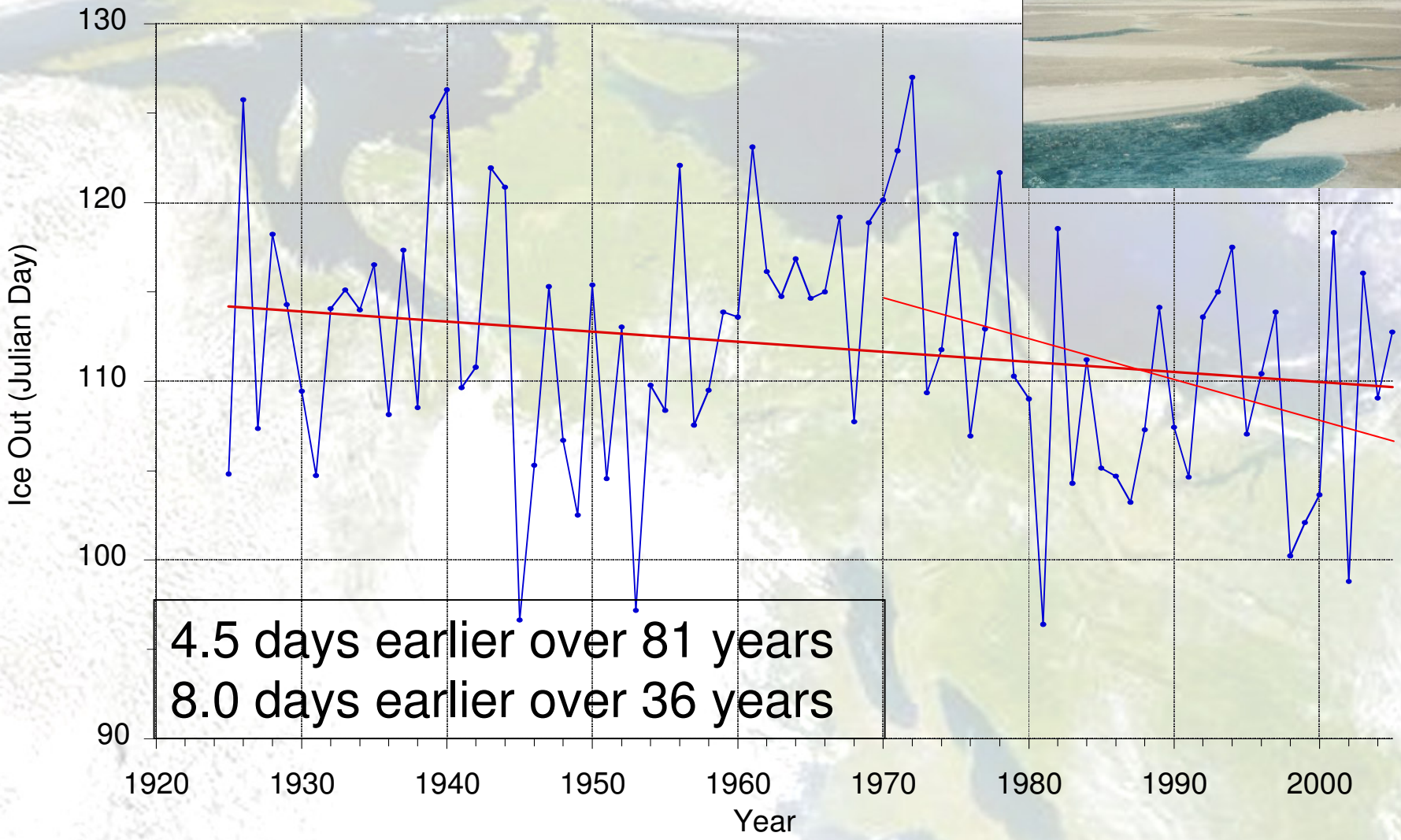
Winter/Spring (1 Jan - 31 May) Center-of-Volume Dates





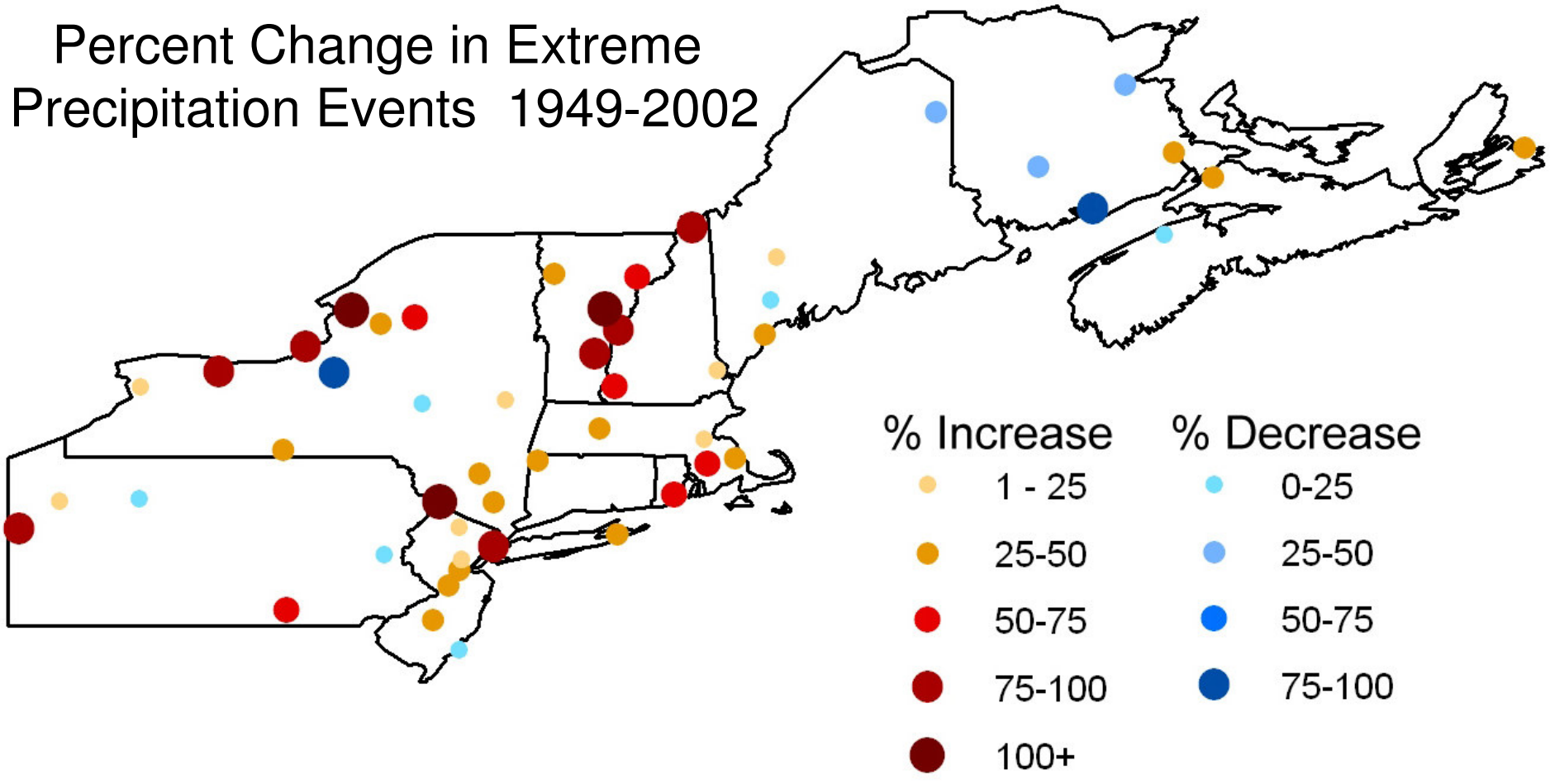
All data from unregulated rivers; Hodgkins et al., 2003

Average Ice Out Day Trend 1925-2005 (27 Lakes)



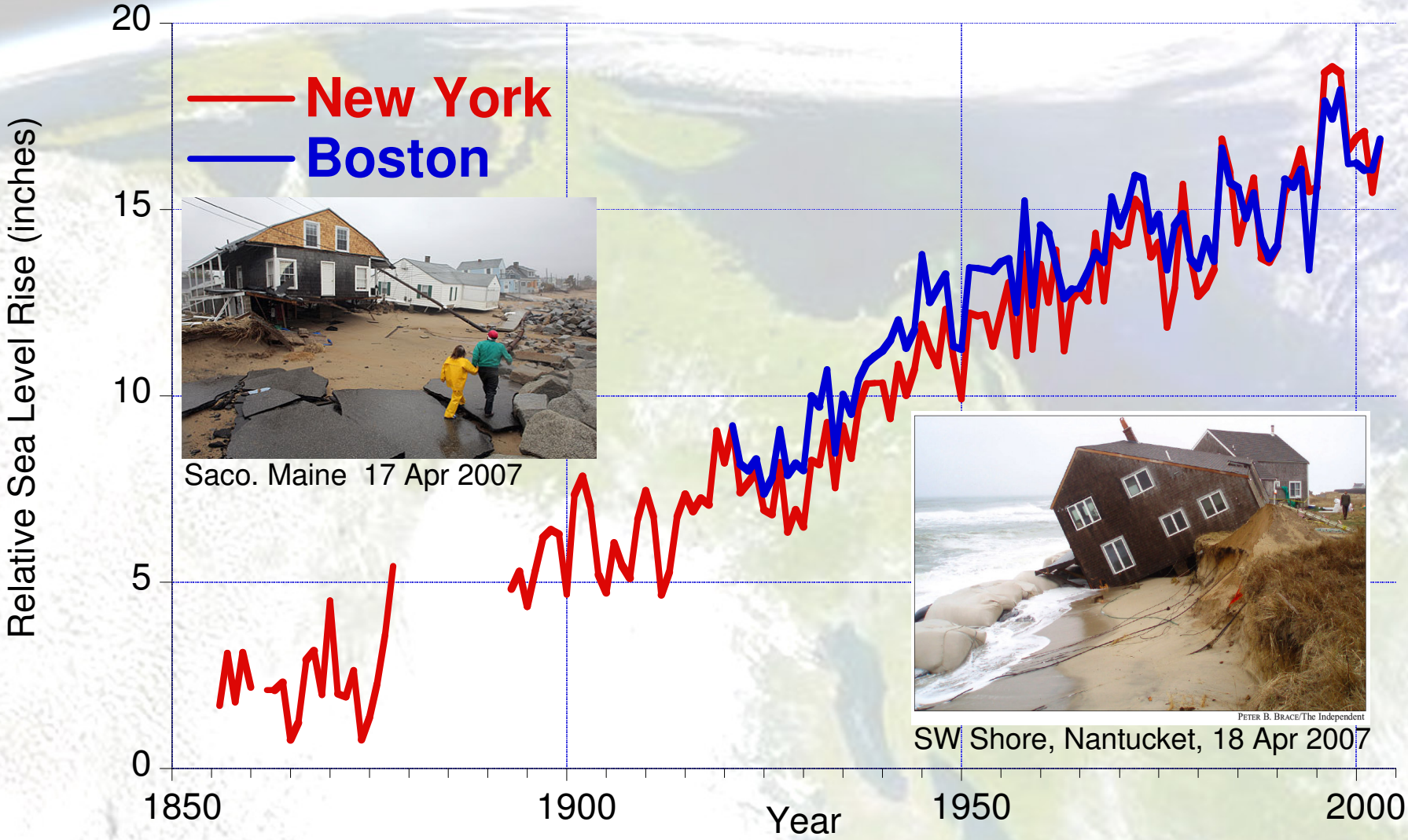
Ice Out data from Hodgkins et al., 2002 and at: http://me.water.usgs.gov/iceout.html

Spatial Variation of Extreme Precipitation Trends: 1970-2002



The extreme precipitation trend was calculated from a linear regression of number of

Relative Sea Level Rise 1856 - 2005



Data from Permanent Service for Mean Sea Level http://www.pol.ac.uk/psmsl/

Difference Between Cold, Snowy Winter and Warm, Slushy Winter

Winter Indicator	Difference in number	Difference in revenue	Percent Change
Alpine Skier Days	309,495	$11.5 million	14%
Nordic Skier Days	43,129	$0.7 million	30%
Snowmobile Licenses	10,892	$1.0 million	26%

Data From: Winter Recreation and Climate Variability in New Hampshire: 1984 - 2006
Report available online at: http://www.carboncoalition.org/

Warming Winters: Impact on Logging Operations

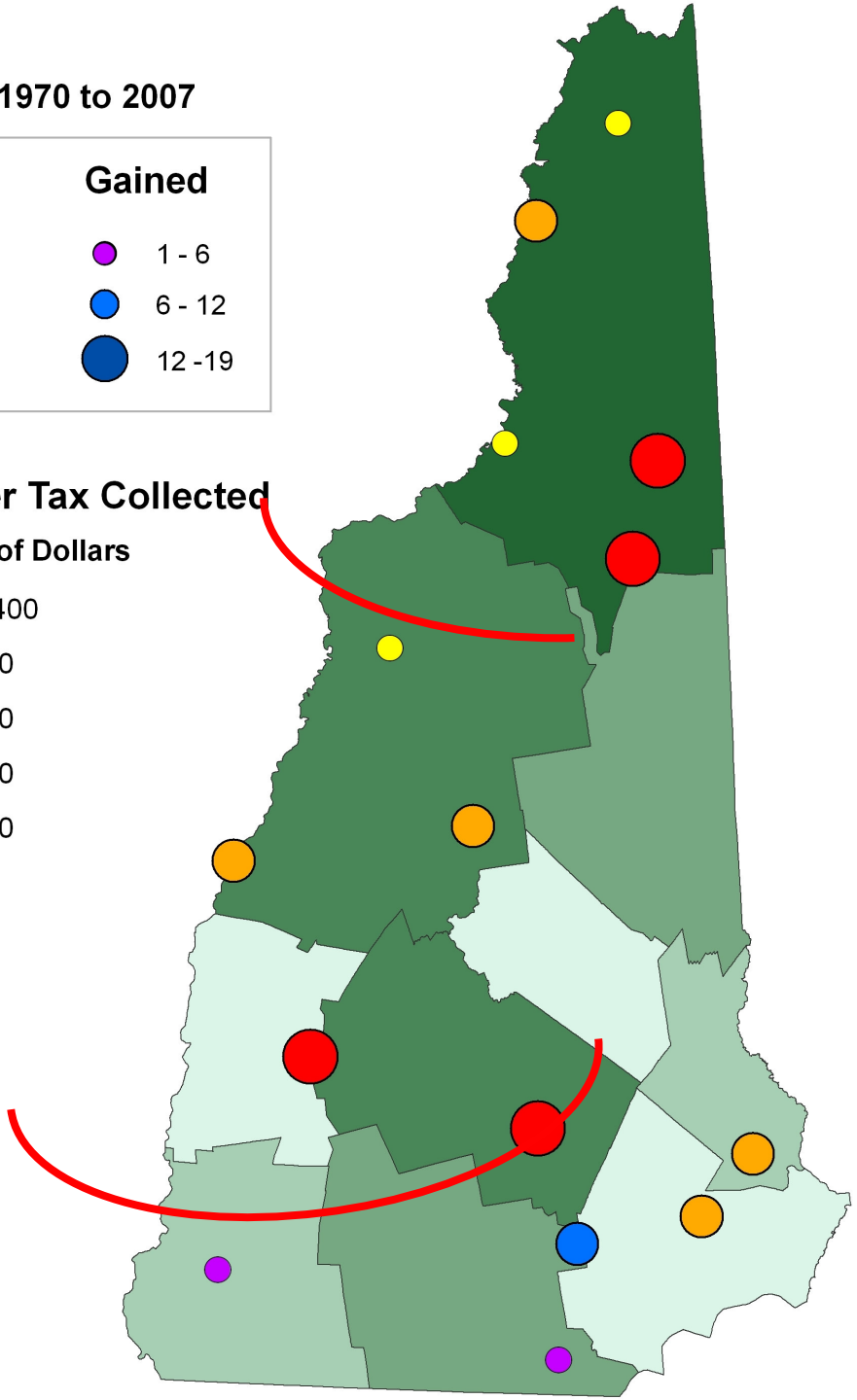
Frozen Days 1970 to 2007

Lost		Gained	
	12 - 19		1 - 6
	6 - 12		6 - 12
	1 - 6		12 -19

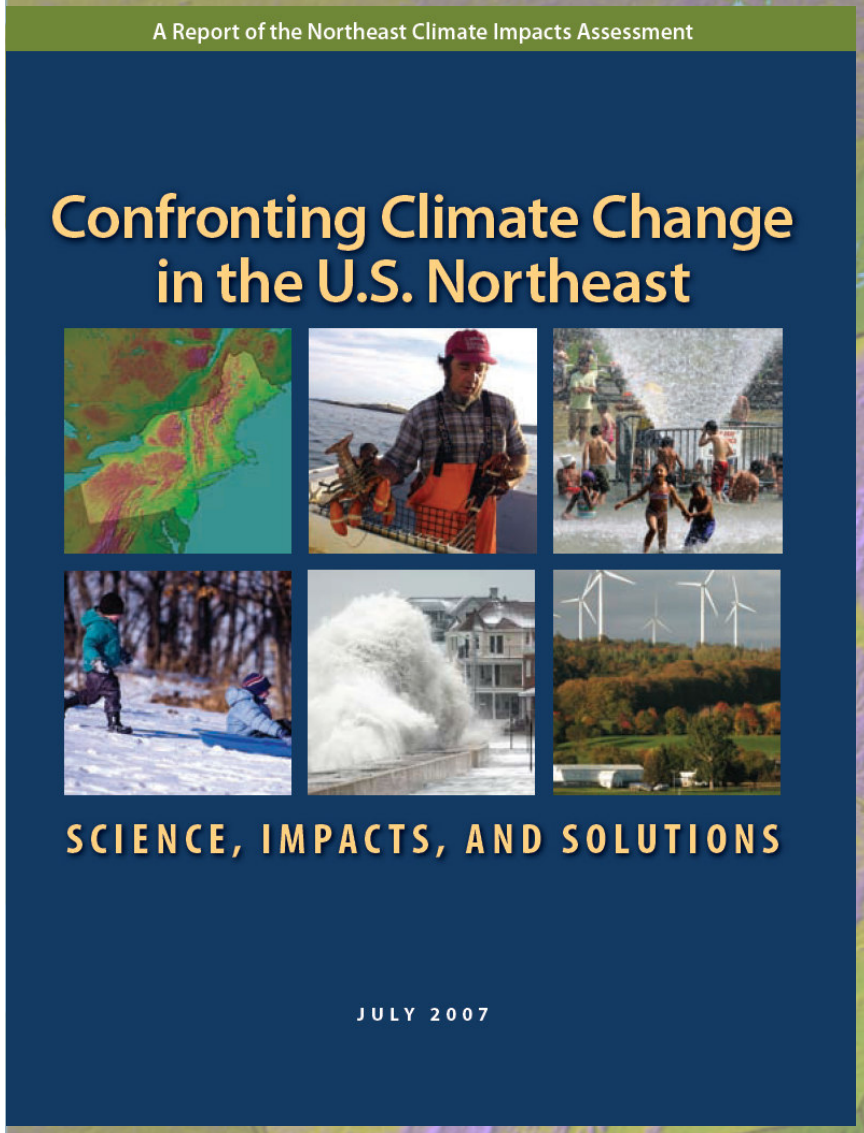
2005 Timber Tax Collected

in Thousands of Dollars

- 630 - 1,400
- 450 - 630
- 420 - 450
- 240 - 420
- 190 - 240



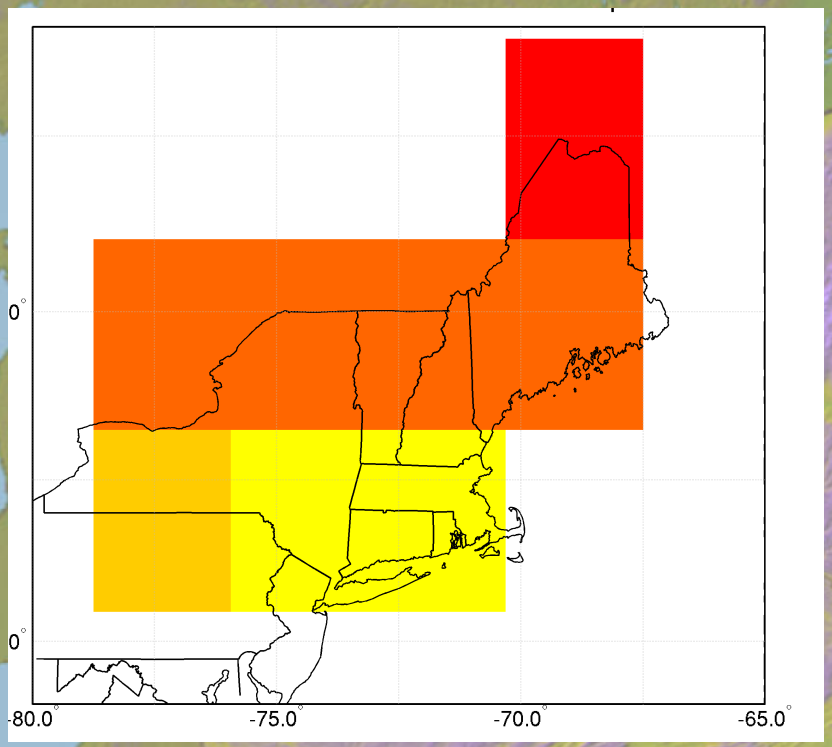
Northeast Climate Impacts Assessment

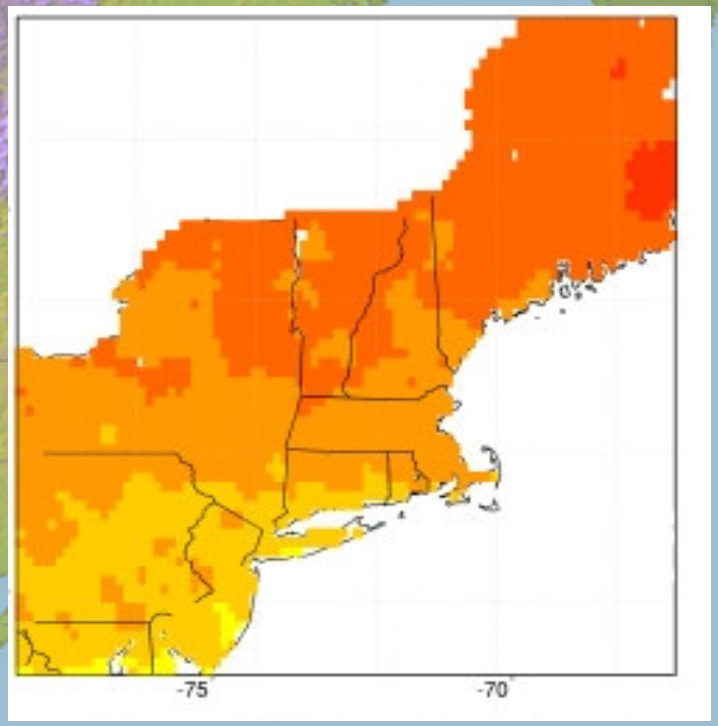


www.climatechoices.org

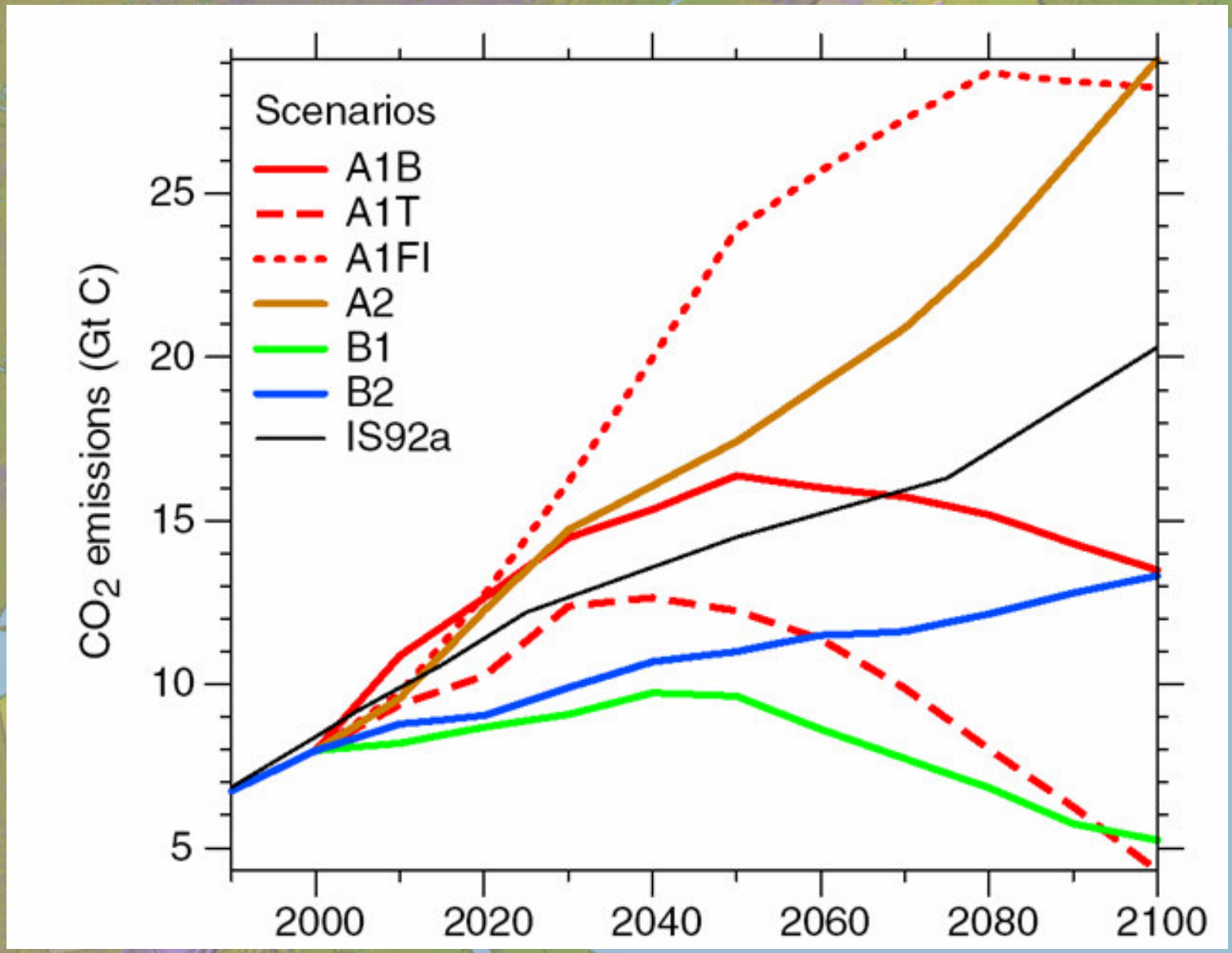
- Collaboration between Union of Concerned Scientists and 50 independent scientists
- **Geographic Scope**
  Nine Northeast states, from Maine to Pennsylvania
- **Peer Review**
  Climate Dynamics, 2007
  14 papers in *Adaptation and Mitigation of Climate Change*, 2008

Projecting Future Climate Change for the Northeast: Downscale Global Projections to Regional Level

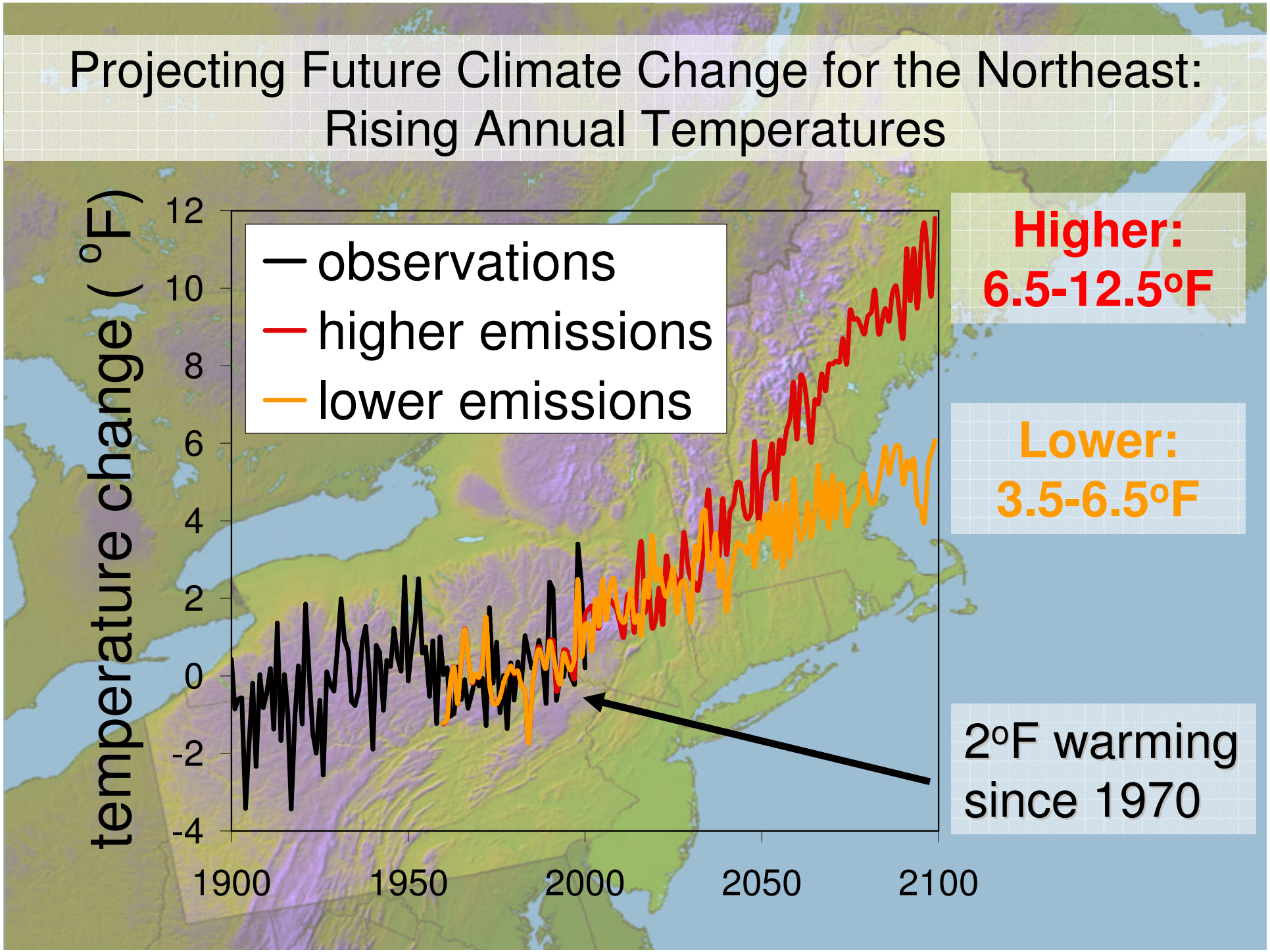




Projecting Future Climate Change for the Northeast: Greenhouse Gas Emission Scenarios



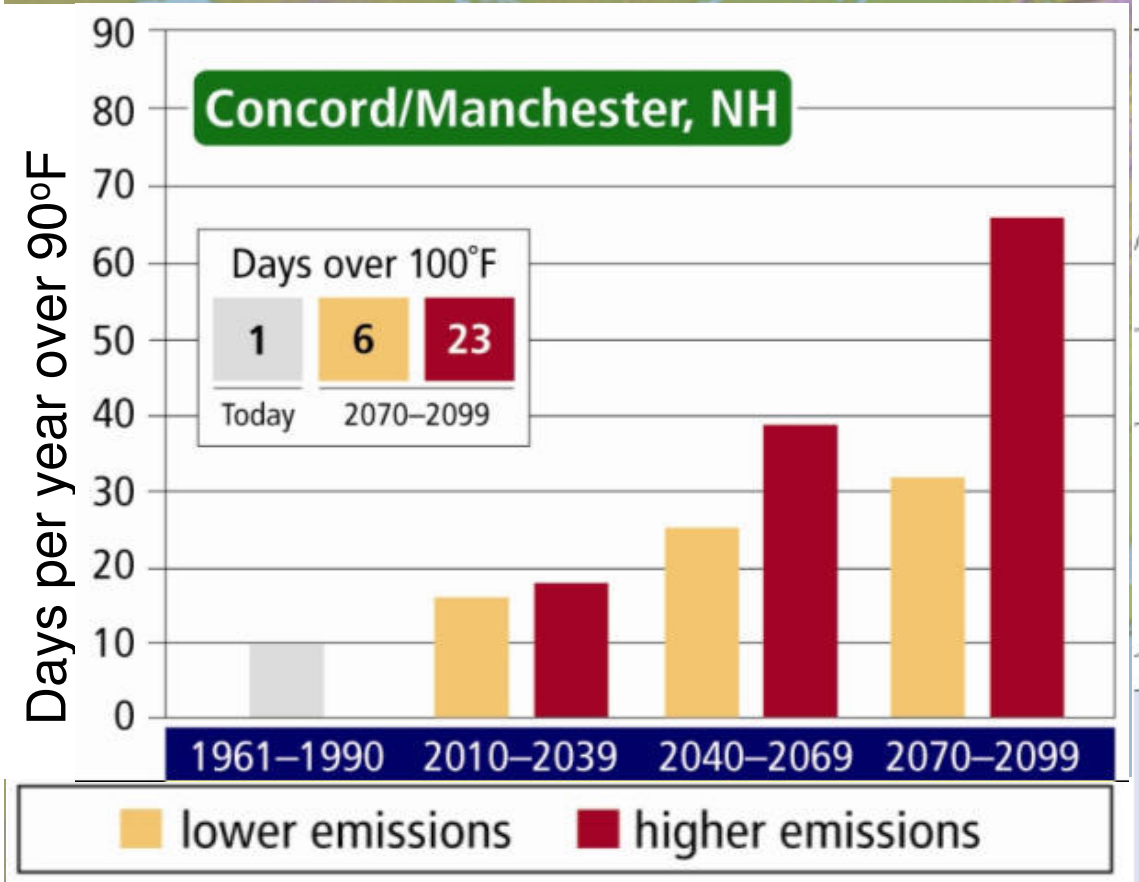
Projecting Future Climate Change for the Northeast: Rising Annual Temperatures

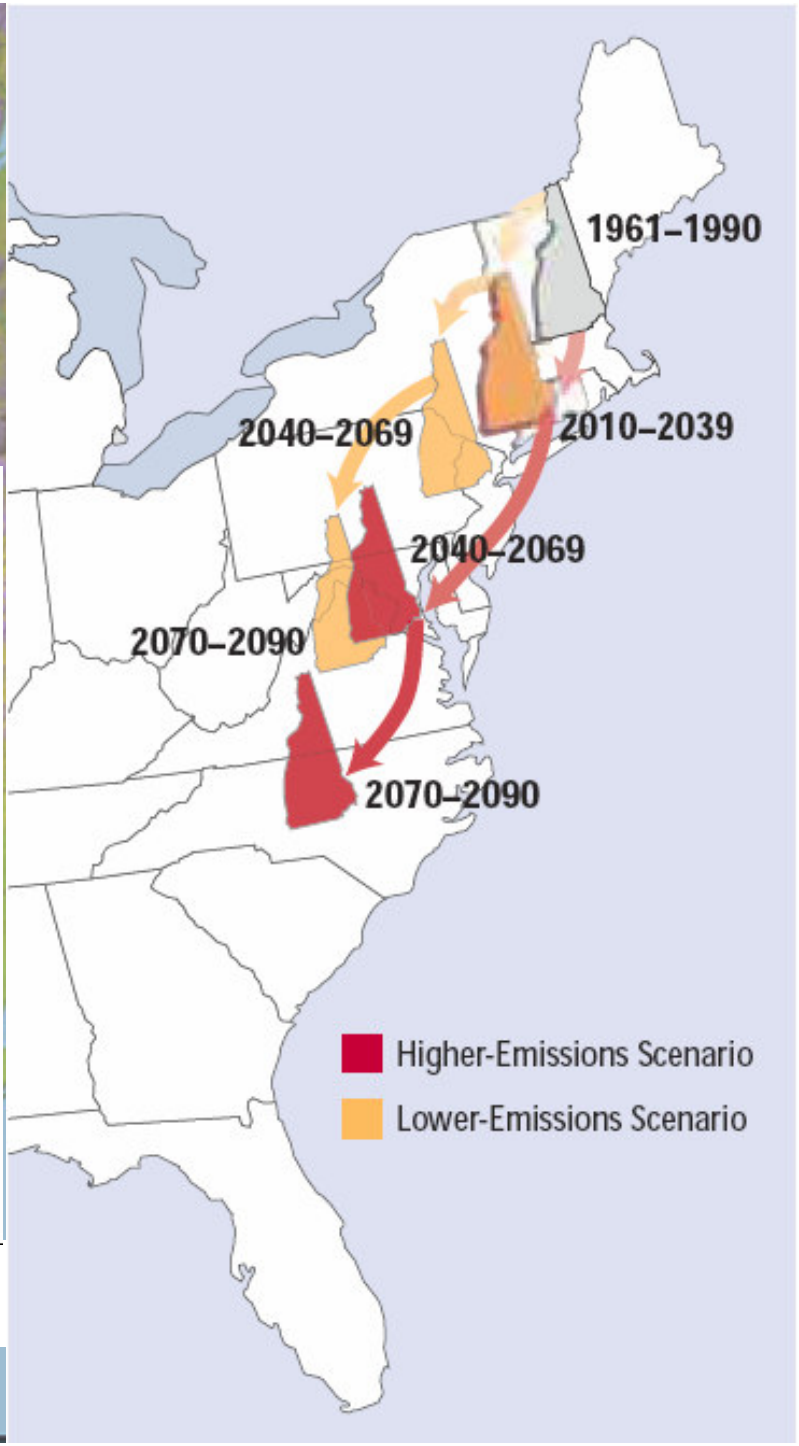


Summer heat index:

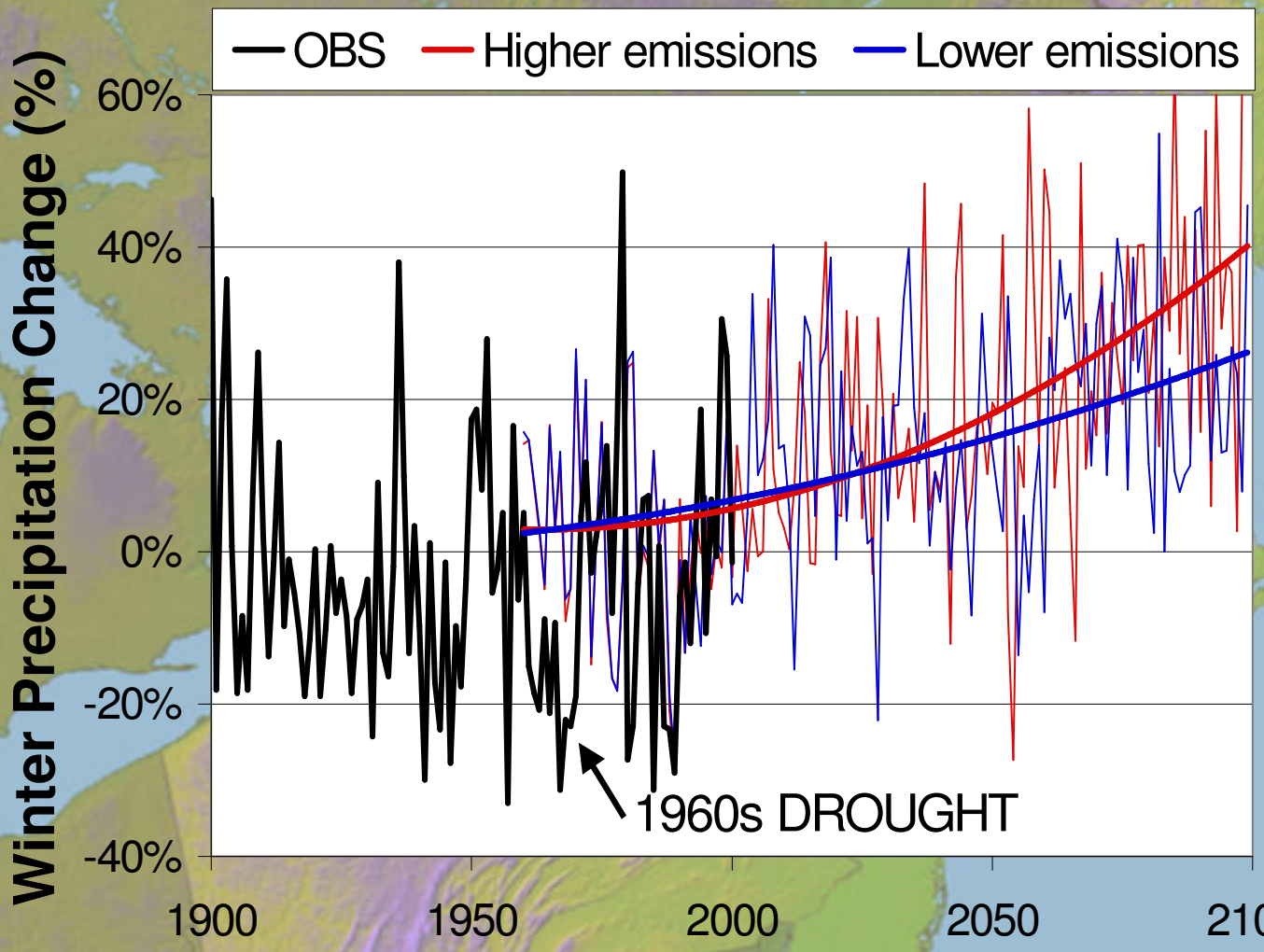
How hot summers will "feel" in

New Hampshire





Increasing winter precipitation



As temperatures rise, more falling as rain, less as snow

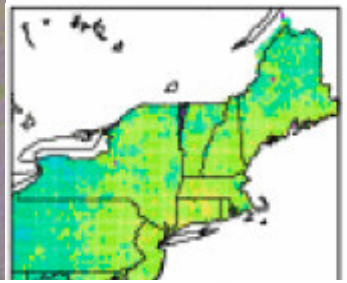
Extreme Precipitation Events Increase

- Heavy rainfall events are becoming more frequent across the Northeast
- Under both emissions scenarios
  - -rainfall is expected to become more intense
  - -periods of heavy rainfall are expected to become more frequent

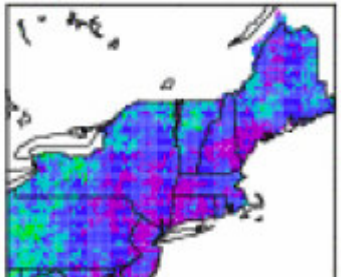
Bridge over Axe Handle Brook, Rochester, NH May 2006.

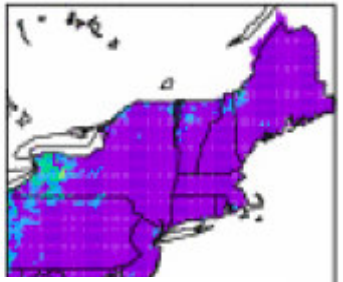
credit: Associated Press

Drought

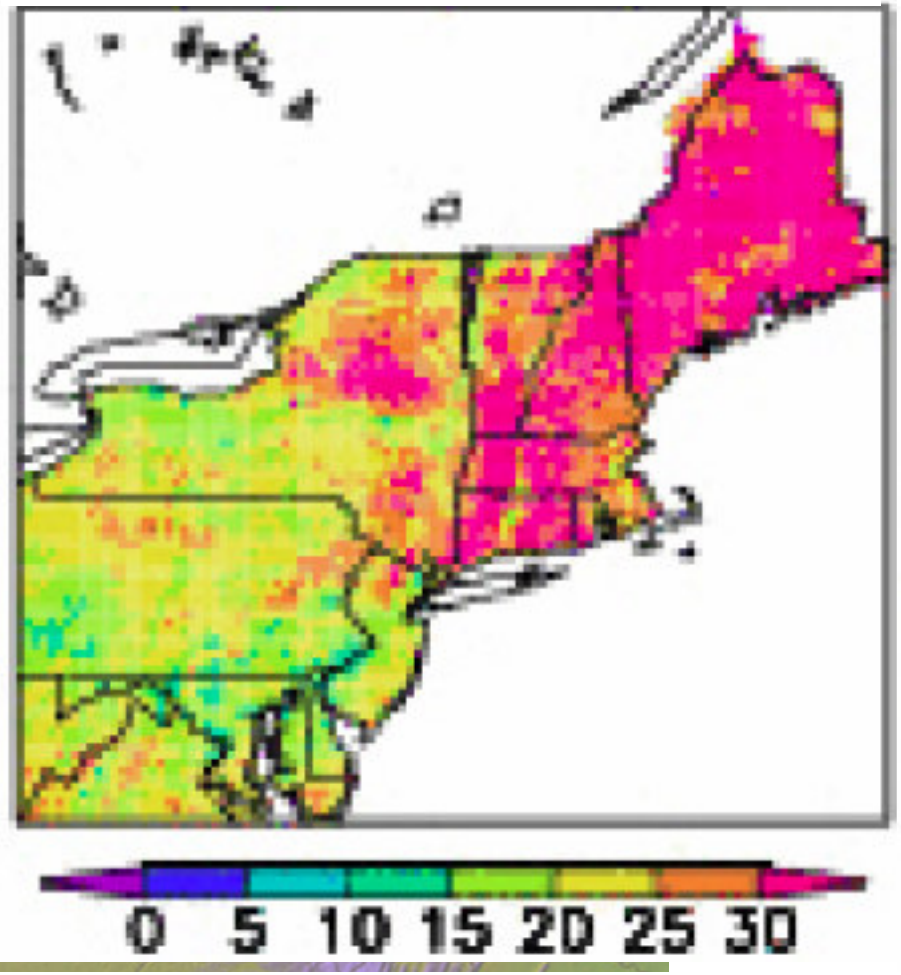


1961-1990

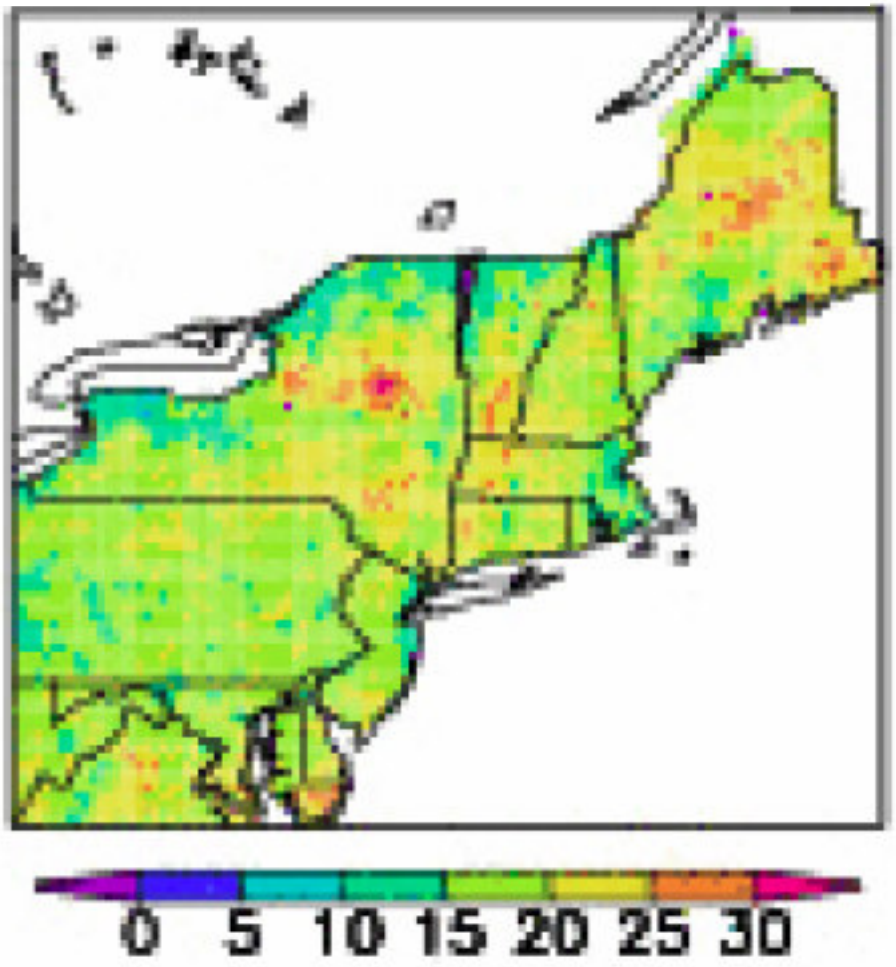




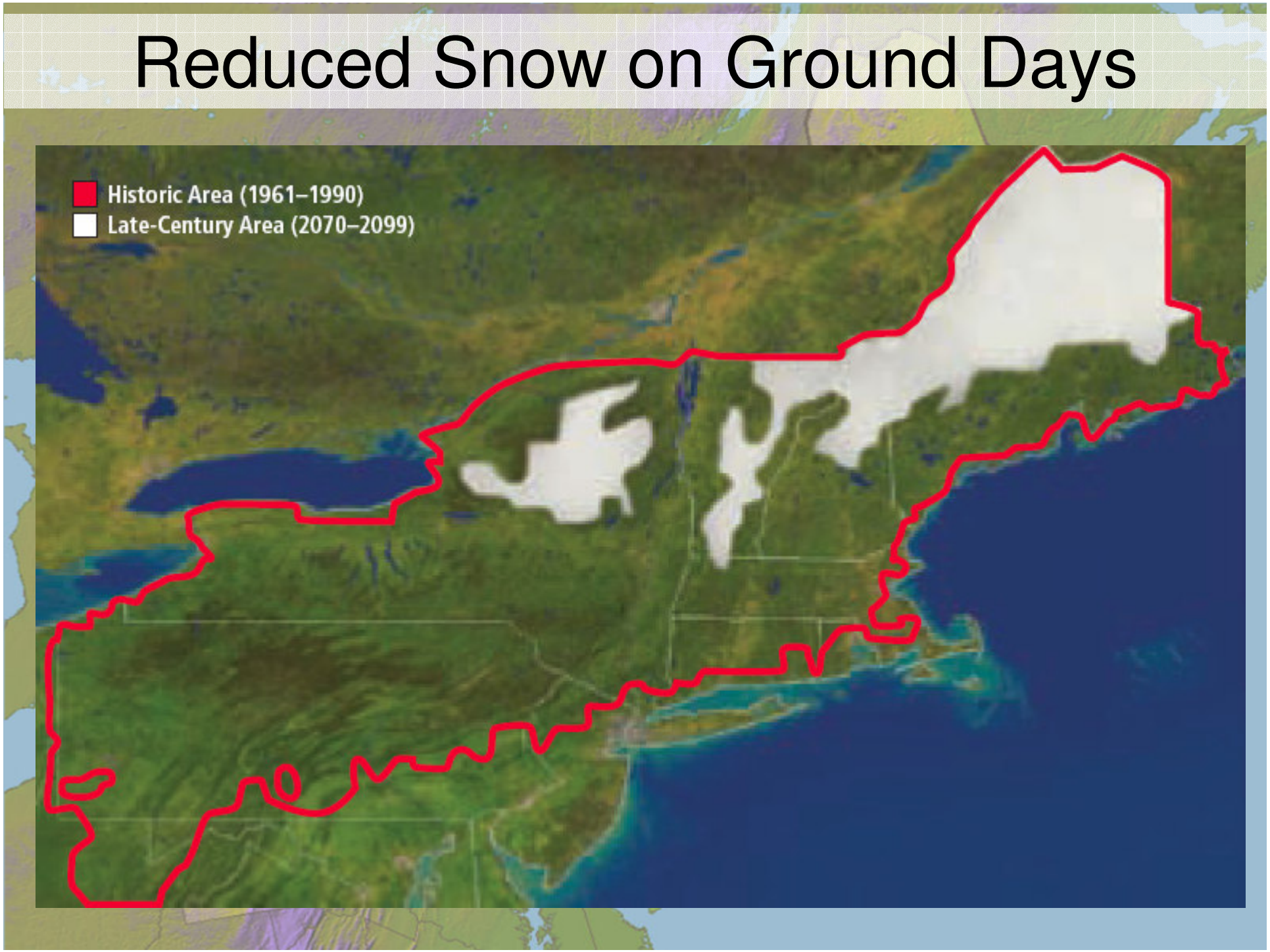
High Emissions



Low Emissions

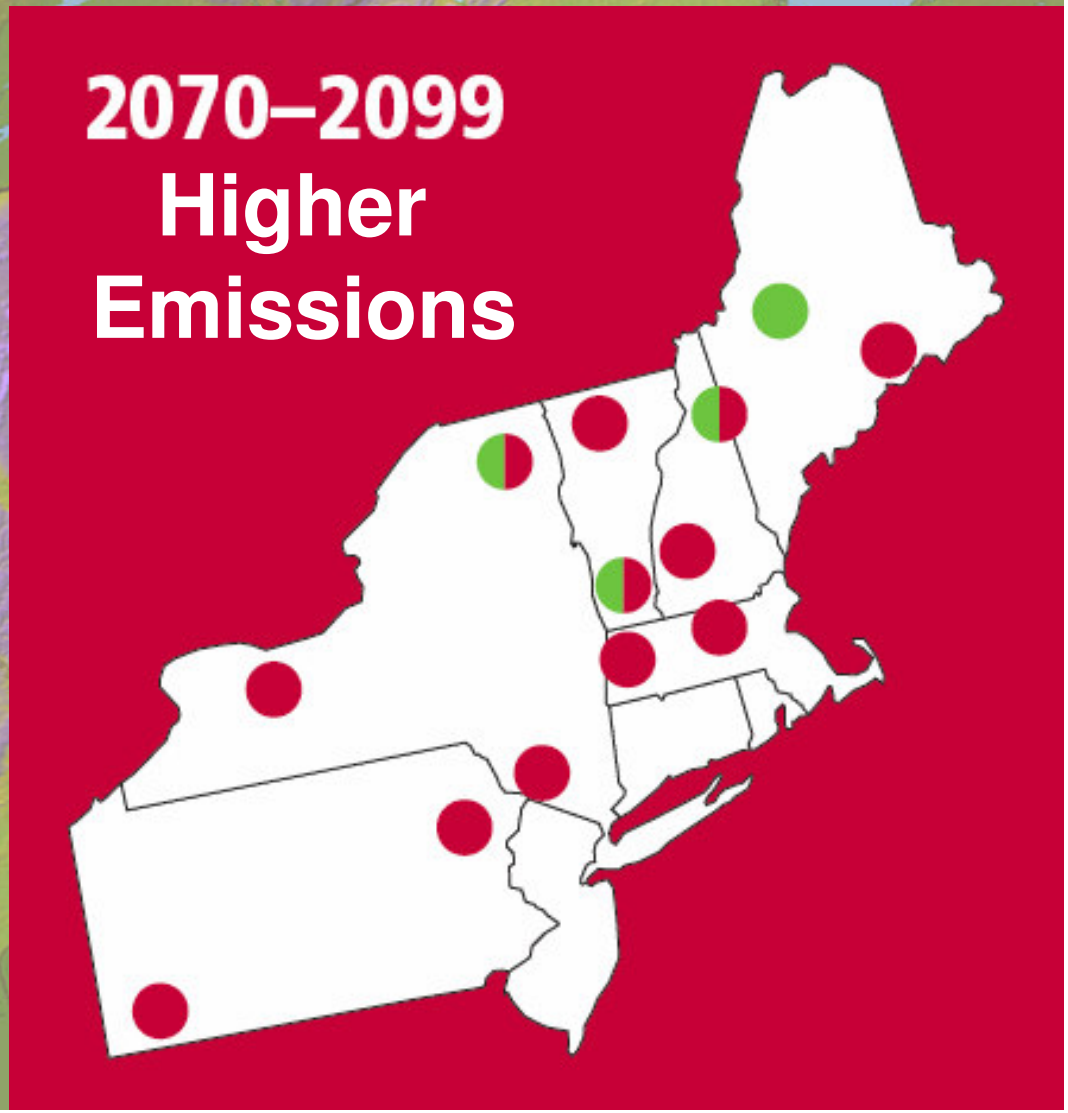


Reduced Snow on Ground Days

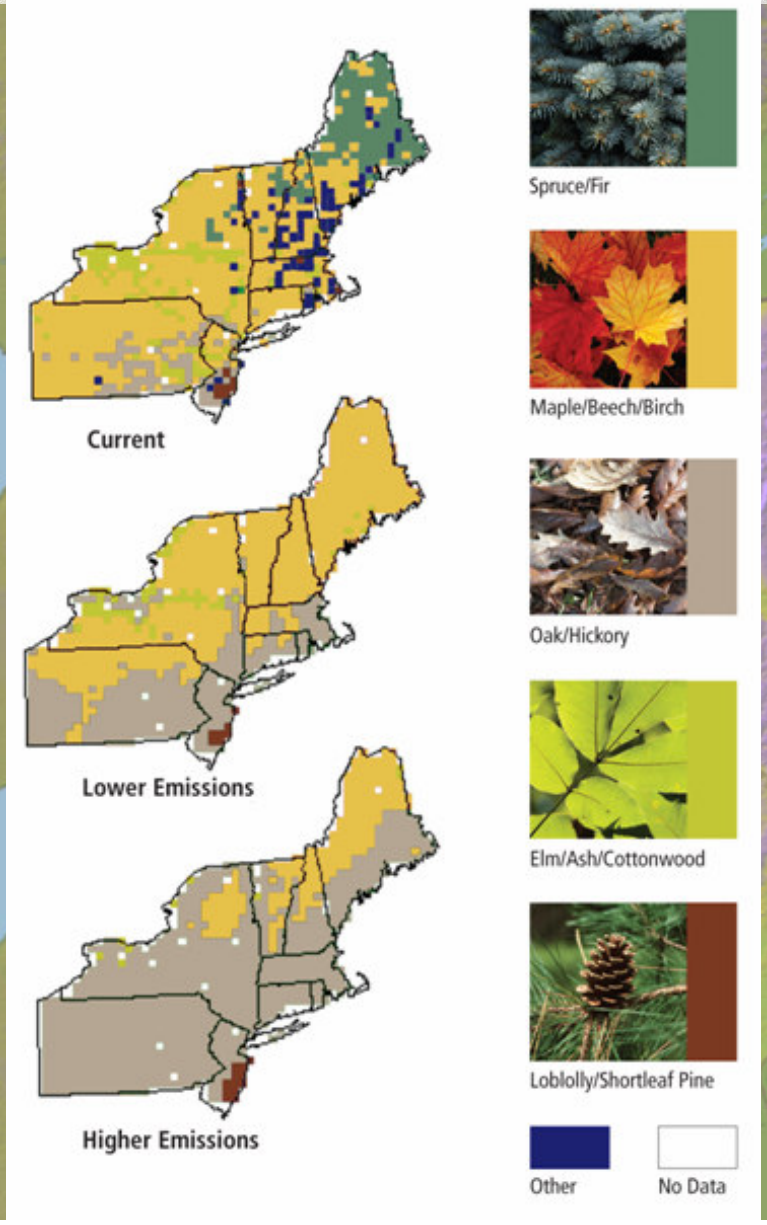


Vulnerability of Ski Resorts to Climate Change

- highly vulnerable
- vulnerable
- viable



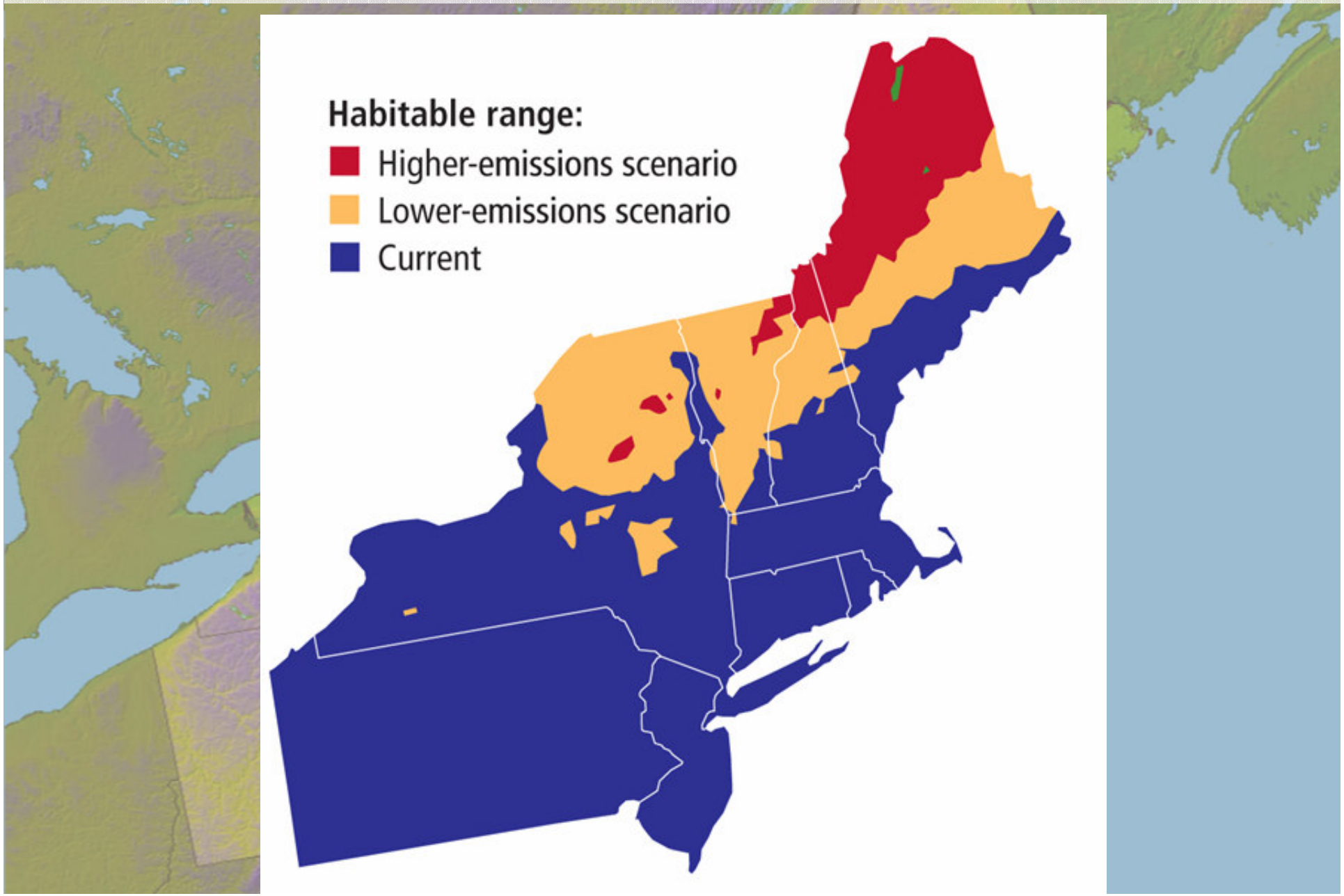
Changes in Habitat Suitability for Different Forest Types by Late-Century



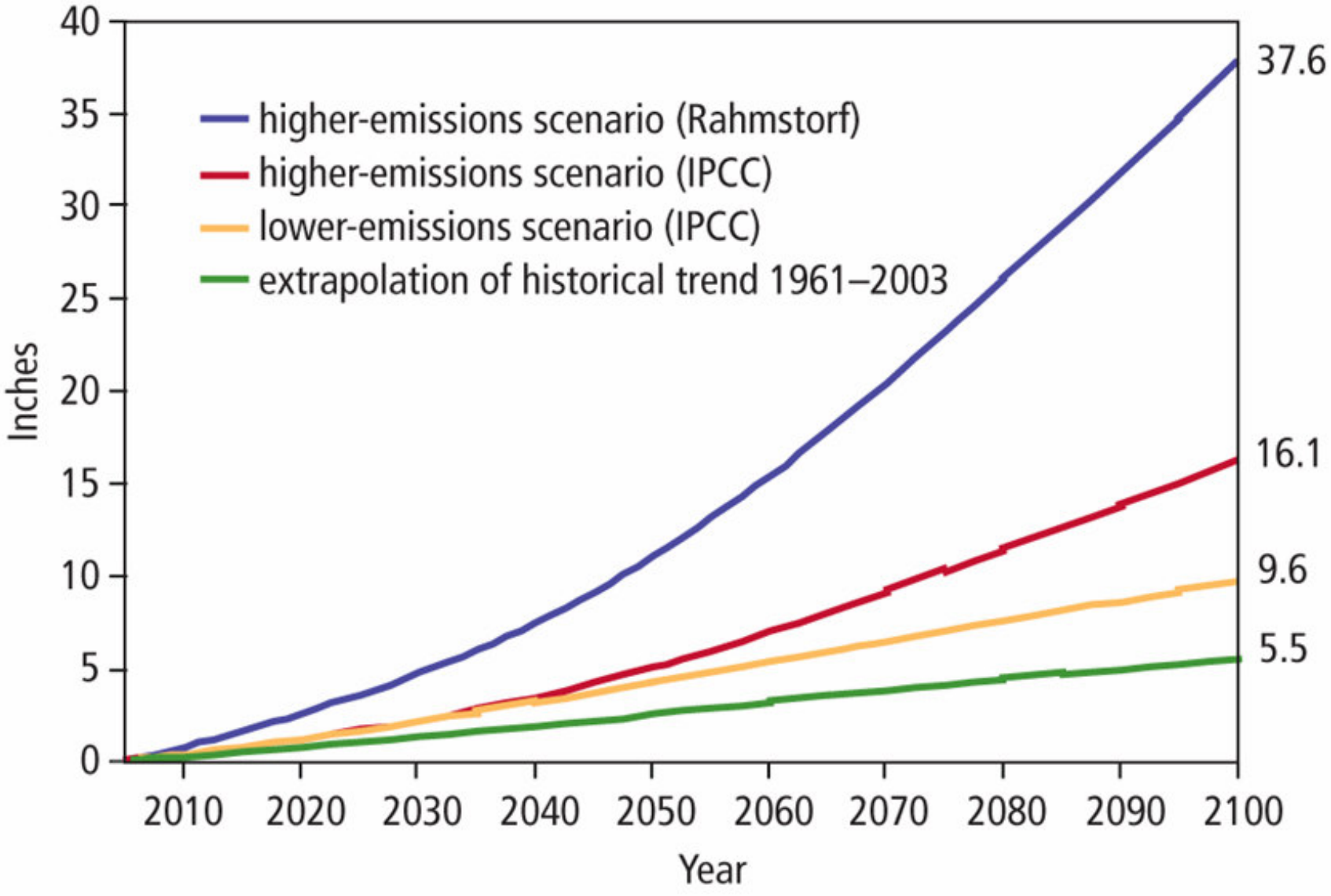
AP Photo/Robert F. Bukaty

Julie Hart

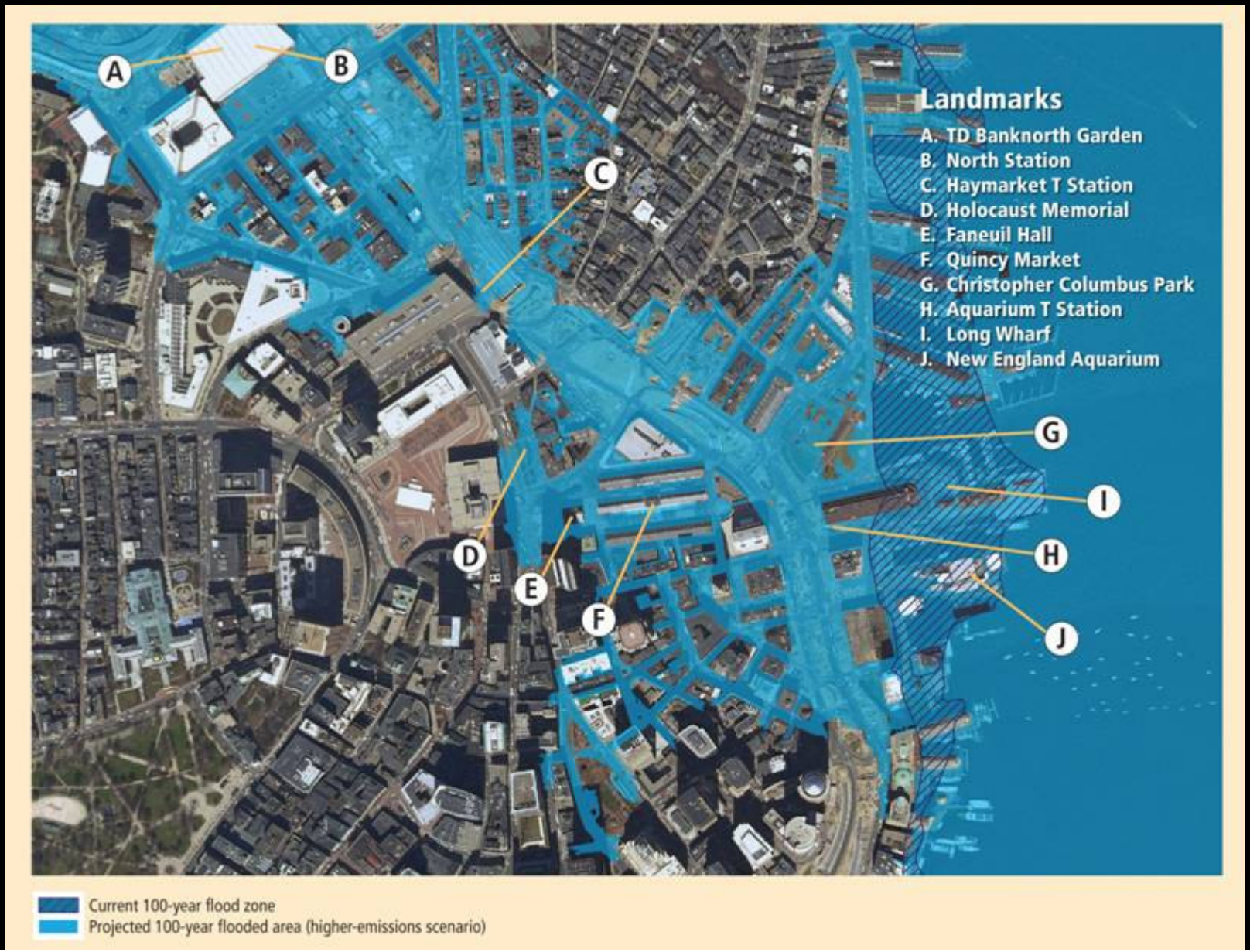
Late-Century Range of Hemlock Woolly Adelgid



Projected Rise in Global Sea Level

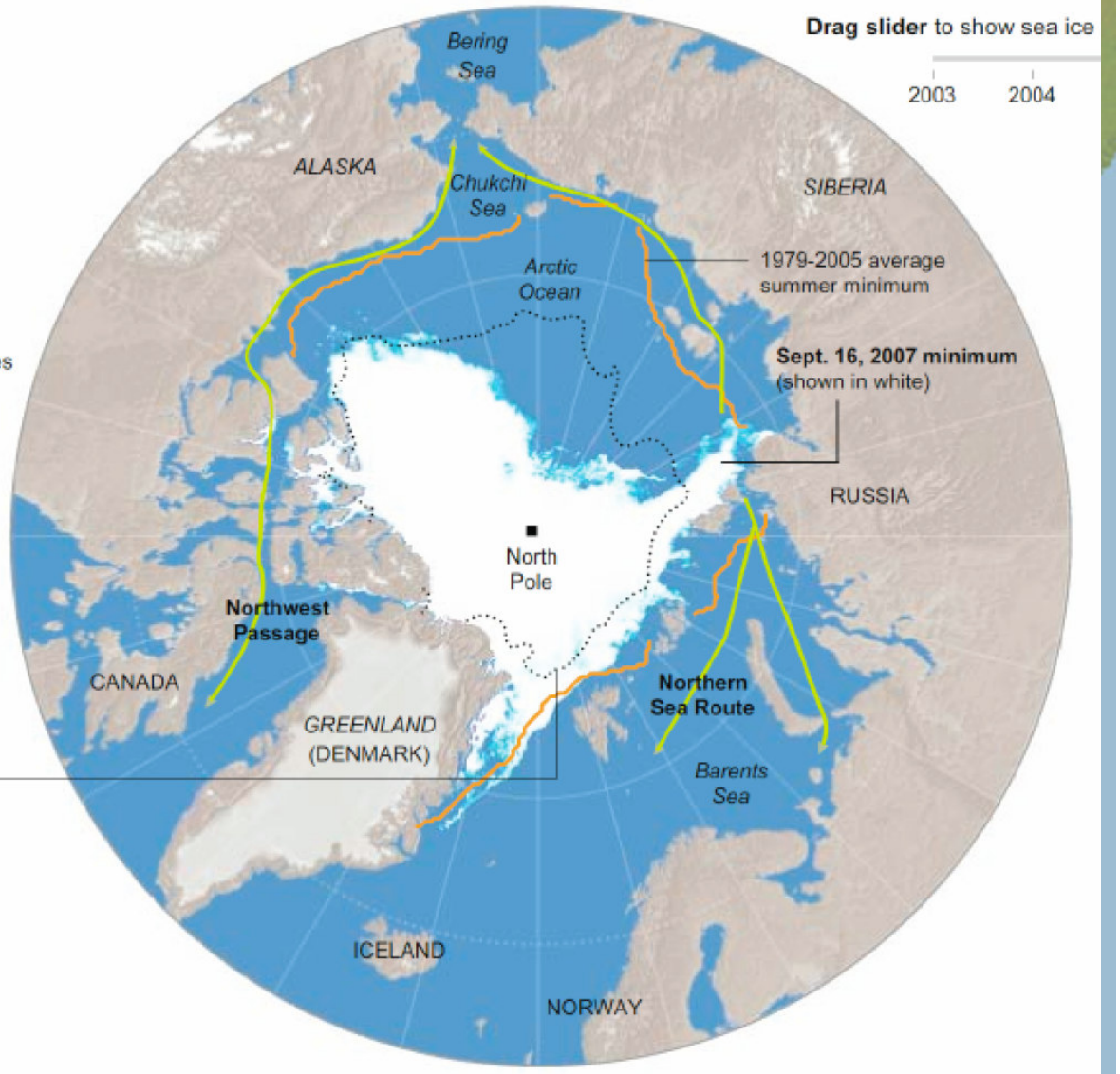


Boston: The Future 100-Year Flood under the Higher-Emissions Scenario

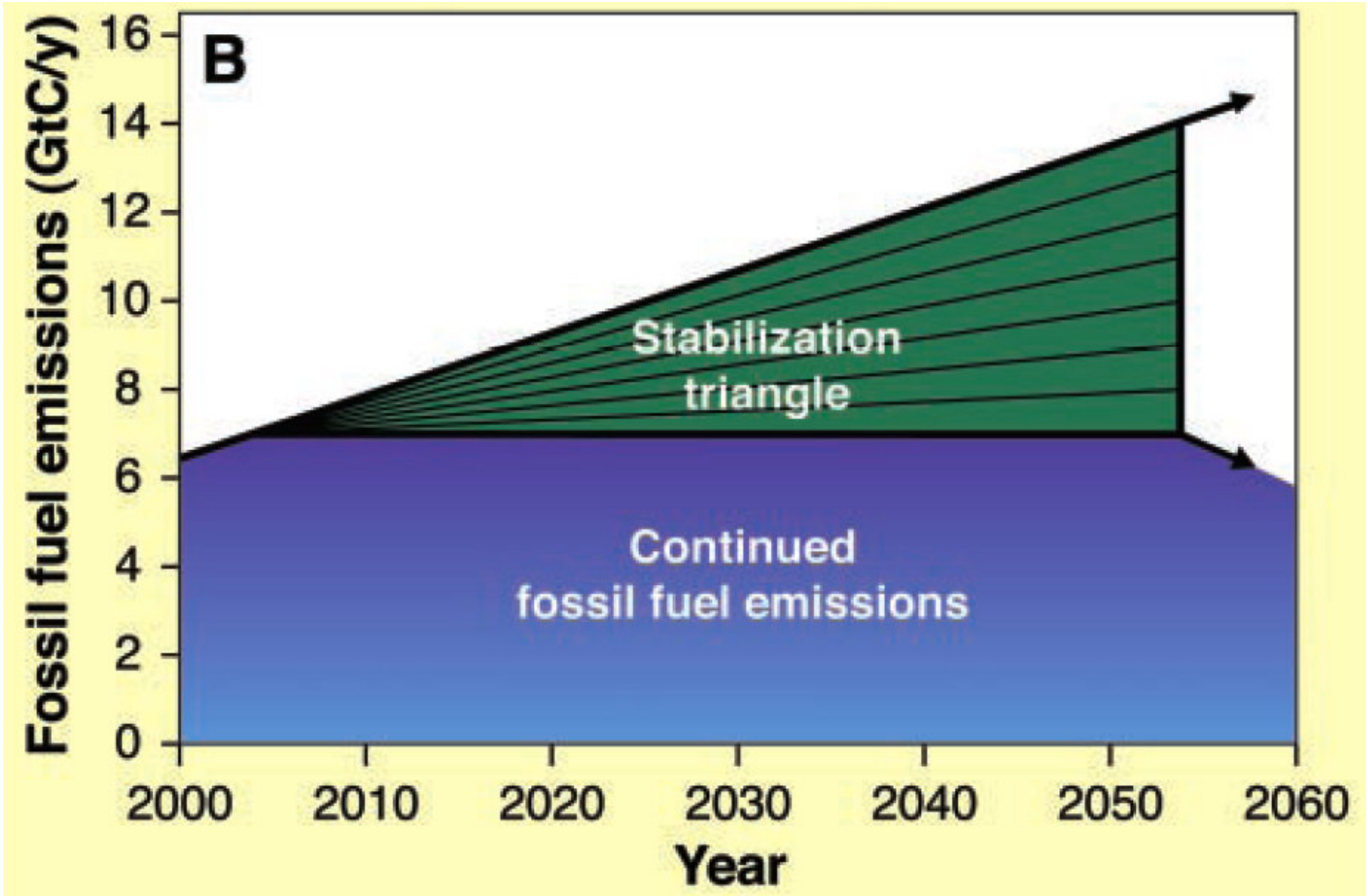


Tipping Points?

Greenland Ice Sheet Melting?



Potential Carbon Emission Reduction Wedges



Pacala and Socolow (2004) Science 304, 968-972.

Potential wedges: Strategies available to reduce the carbon emission rate in 2054 by 1 GtC/year (Pacala and Socolow, 2004)

1. Efficient vehicles
2. Reduced use of vehicles
3. Efficient buildings
4. Efficient baseload coal plants
5. Gas baseload power for coal baseload power
6. Capture CO2 at baseload power
7. Capture CO2 at H2 plant
8. Capture CO2 at coal-to-synfuels
9. Nuclear power for coal power
10. Wind power for coal power (add 2 million 1-MW windmills)
11. PV power for coal power
12. Wind H2 in fuel-cell car for gasoline in hybrid car
13. Biomass fuel for fossil fuel
14. Reduced deforestation
15. Conservation tillage

What path will we take to the future?

Two roads diverged in a wood, and I -
I took the one less traveled by,
And that has made all the difference.

Robert Frost